Design and Implementation of Efficient Search Methodology for Content-Based Retrieval in E-Learning Environment

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Abstract - **E-Learning portal is the full of content of different formats like text, metadata, image, audio, and video. Current search methodologies have a direct impact on the fundamental retrieval issues that information seekers encounter in their use of the vast number of search systems on the web today. Recently, information retrieval for text and multimedia content has become an important research area. Content-based retrieval in multimedia is a challenging problem since multimedia data needs detailed interpretation from pixel values. Based on several new technologies, such as ubiquitous computing, ontology engineering, semantic web and grid computing, it is observed that for flexible educational platform architecture for E-Learning that is OntoEdu is must. In this paper we offer review report of E-Learning architecture and propose efficient search algorithm to retrieve multimedia content from the E-Learning environment. The purpose of this technique is to efficient and fast retrieval of data from content based environment. The results of these proposed searching techniques have been found satisfactorily.**

Keywords- **Content based retrieval, Syntactic indexing, Semantic indexing, Perceptual features, Matching techniques e-learning, Ontology, Grid Computing, Learning methods**

I.INTRODUCTION

Architecture on E-Learning Grid has been proposed by Victor Pankratius, Gottfried Vossen [1] in the year 2003. In that paper they proposed the basic architecture of Grid Computing (Fig 1). The grid computing paradigm essentially aggregates the view on existing hardware and software resources. The proposed architecture is the combination of Core Grid Middleware and Learning Management System which content two set of database one maintain in grid level operation and another one maintain the content retrieval. In this paper our focus is to present efficient and fast search the content as per the learner's requirement. It can only be done if we can organize the content with appropriate architecture. We reviewed learning management system architecture and their file system. Content organization is one of the major concerns in E-Learning paradigm. E-Learning Portal has resulted in a substantial progress in the multimedia and storage technology that has led to building of a large repository of digital image, video, and audio data. There is a controlled vocabulary or thesaurus provided. Hybrid search systems are also found among search engines; however, it is the popularity of full text searching that has changed the road map to information access. However, searching for a multimedia content is not as easy because the multimedia data, as opposed to text, needs many stages of pre-processing to yield indices relevant for querying. Since an image or a video sequence can be interpreted in numerous ways, there is no commonly agreed-upon vocabulary. Thus, the strategy of manually assigning a set of labels to a multimedia data, storing it and matching the stored label with a query will not be effective. As per the grid architecture [1], the large volume of video data makes any assignment of text labels a massively labor intensive effort. In recent years, research has focused on the use of internal features of images and videos computed in an automated or semi-automated way [2]. Automated analysis calculates statistics, which can be approximately correlated to the content features. The common strategy for automatic indexing had been based on using syntactic features alone. However, due to its complexity of operation, there is a paradigm shift in the research of identifying semantic features [4]. Web based courses are now developed and presented through so-called Learning Management Systems such as Blackboard or WebCT (Web Course Tools). Learning Management systems are powerful integrated system that supports a number of activities performed by teachers and students during the E-Learning process. Our proposed searching algorithm is based on the proposed architecture on E-Learning Grid [1]. This paper put forward the efficient searching mechanism to retrieve data from the content based portal. The organization of the paper is as follows:

The abstraction of the content organization and the need of searching under e-learning environment have been explained in Section II. The basic architecture of e-learning environment, grid computing, is explained in Section III. The proposed algorithm and its explanation for image and video search are presented in Section IV. The implementation of the algorithm is explained in section V, Result and

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conclusion is described in section VI and references in section VII.

II.ABSTRACTION OF THE CONTENT ORGANIZATION AND SEARCHING NEED

The technological landscape of modern E-Learning environment is dominated by Learning Management System. Efficient and effective handling of text, audio and video documents depends on the availability of indexes. Manual indexing is unfeasible for large video collections. Content organization is also an important issue. In the existing environment, Learning Management System, there is a lack of proper searching of contents. The multimedia contents are stored along with the subsequent text information in the database. When learner searches the multimedia content then it searches that text from the database. In case of spontaneous uploading of multimedia content along with instant retrieval is not possible. It is not acceptable for content based retrieval. In this paper we proposed direct multimedia content searching methodology from E-Learning environment. The Grid architecture is used which is based on ontology technology, Grid technology, Semantic Web technology. The content based retrieval is categorized into basic three types of multimedia content Audio, Video and Text. For each category same type of searching methodology is used.

III.BASIC ARCHITECTURE OF THE E-LEARNING ENVIRONMENT

The Architecture, we have observed that searching text, audio and video from the learning environment with different courses is too complicated. We have found that learners when going to search the object from their enrol content then before searching it must check the authentication and then search the content. The Core grid database will control the enter scenario of the particular learner. It maintain number of database as per the level of security of the organization. This is called grid level activity. Another division of architecture is called Learning Management System (LMS). After overcoming the LMS the control comes to the search the desired data. First it checks the content type, and then it proceeds to search.

Multimedia content can be modeled as a hierarchy of abstractions. At the lowest level are the raw pixels with unprocessed and coarse information such as color or brightness. The intermediate level consists of objects and their attributes, while the human level concepts involving the interpretation of the objects and perceptual emotion form the highest level. Based on the above hierarchy, descriptive features in multimedia, furnished to the users of content-based technology, can be categorized as either syntactic features or semantic features [5]. A syntactic feature is a low-level characteristic of an image or a video such as an object boundary or color histogram. A semantic feature [3], which is functionally at a higher level of hierarchy, represents an abstract feature. Whereas the label grass assigned to a region of an image or descriptor ‘empathy of apprehension’ for a video shot (a shot is a sequentially recorded set of frames representing a continuous action in time and space by a single camera). At higher level of user interaction, the semantic features are more useful as compared to the syntactic features [6].

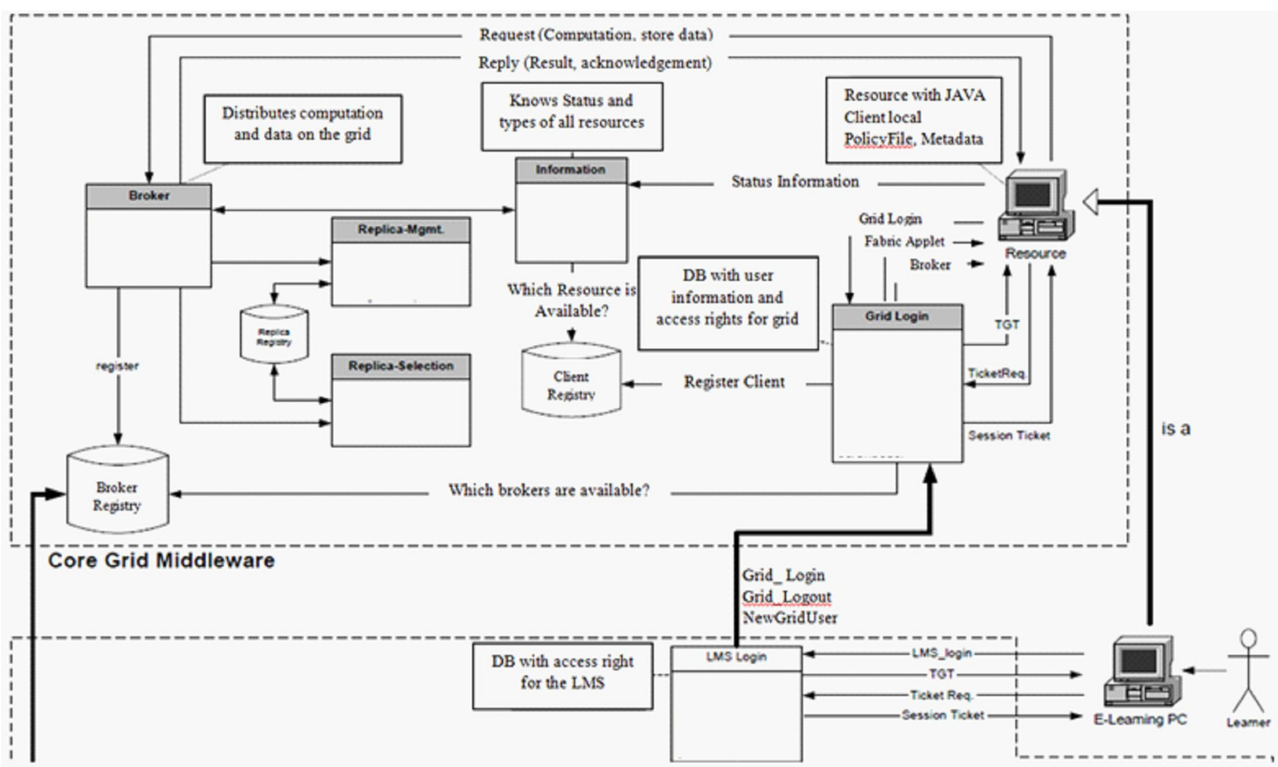

Figure1: Learning Management System (LMS) – Grid Model

IV.PROPOSED ALGORITHM

As per the architecture of the grid architecture of E-Learning, we propose the video searching algorithm based on Semantic and Syntactic Indexing technique. Semantic search seeks to improve search accuracy by understanding learners intent and the contextual meaning of terms as they appear in the searchable dataarea, whether on the Web or within a closed system, to generate more relevant results.

User's query: A query specified by the user is translated directly into pruning operations on intrinsic parameters. In a query is specified by the colors, sizes and arbitrary spatial layouts of the color regions, which include both absolute and relative spatial locations.

To find the region that best match:

$$Q = \{ cq; (xq; yq); areaq; (wq; hq)\}$$

The query is processed by first computing the individual queries for color, location, size and spatial extent. Query object X, the goal is to find all objects Y in the collection such that the distance d(X, Y) is within an allowed range. A simple representation for objects with D numeric attributes is to represent them by points in D-dimensional space. One particular class of distance functions commonly used with such a representation are the l_p norms, where the distance between points $X(X_1, \ldots, X_D)$ and $Y(Y_1, \ldots, Y_D)$ is given by

$$d(x,y) = \left(\sum_{1 \le i \le D} (x_i - y_i)^p \right)^{\frac{1}{p}}$$

For the complex data, objects are better represented by a set of feature vectors, each a point in some high dimensional space with an associated weight. The general mathematical representation for a feature-rich data object is:

$$X = \{< X_1, \omega(X_1) > \ldots, < X_k, \omega(X_k) >\}$$

Where $X_i = (X_{i1}, \ldots, X_{iD})$, $\omega(X_i)$ is the weight of X_i, and k is variable. Since k may vary from object to object, this representation is flexible and applicable to most feature-rich data types.

The algorithm is proposed to find image or video object distance and results will be returned accordingly.

The sketch construction unit constructs a bit vector (sketch) for each high-dimensional feature vector, such that the l_1 distance of two high-dimensional feature vectors can be estimated by computing Hamming distance between sketches, via XOR operations. To initialize the sketch construction unit, one needs to specify:

- N: sketch size in bits,
- min[D]: min values of the D dimensions,
- max[D]: max values of the D dimensions,
- ω[D] (optional): the weight of each dimension, and
- K (optional): threshold control whose default value is 1. When K is greater than 1, the sketch construction unit produces sketches approximating a transformed version of the segment distance (akin to applying a threshold) to reduce the effect of outliers.

Algorithm 1: Generate N × K Random (i, t) Pairs

Input: N,K,D,min[D],max[D],w[D]

Output: p[D], rnd_i[N][K], rnd_t[N][K]

$p_i = w_i \times (max_i$ “ $min_i)$; for i = 0, . . . ,D “ 1

normalize p_i s.t. $\sum_{i=0}^{d-1} pi = 1.0$

```
for (n = 0; n < N; n + +) do
   for (k = 0; k < K; k + +) do
                pick random number r  € [0, 1)
find i    s.t. Σ_{j=0}^{i-1} pi ≤ r < Σ_{j=0}^{i} pi
rnd_i[n][k] = i
pick random number t  € [min_i,max_i]
rnd_t[n][k] = t
        end for
     end for
```

Algorithm 2: Convert Feature Vector to N-Bit Vector

```
Input: v[D],N,K, rnd_i[N][K], rnd_t[N][K]
Output: b[N]
for (n = 0; n < N; n + +) do
x = 0
    for (k = 0; k < K; k + +) do
         i = rnd_i[n][k]; t = rnd_t[n][k]
         y = (v_i < t)? 0: 1
         x = x XOR y
    end for
    b_n = x
end for
```

Analysis: We briefly explain the intuition behind the sketch construction procedure and refer the reader to [8] for technical details and proofs. Algorithm 1 shows the initializing process, where N × K random (i, t) pairs are generated. Then, for every high dimensional feature vector, Algorithm 2 constructs N × K bits using the (i, t) pairs generated by Algorithm 1. This procedure is designed such that the expected distance between any pair of such N ×K bits is proportional to the l_1 distance between the corresponding high dimensional feature vectors. Further, every group of K bits are XORed to produce the final N-bit sketch. The Hamming distances between these final bit vectors are proportional to a transformed version of the l_1 distances between the feature vectors.

V.IMPLEMENTATION

The implementation of the algorithm is very prospective. The main issue is that one object may be matched with the number of different queries. It is very important to input the data with proper attribute. One multimodal object could be the result of multiple queries. The proposed algorithm works as the block, which is sketched below (Figure: 2)

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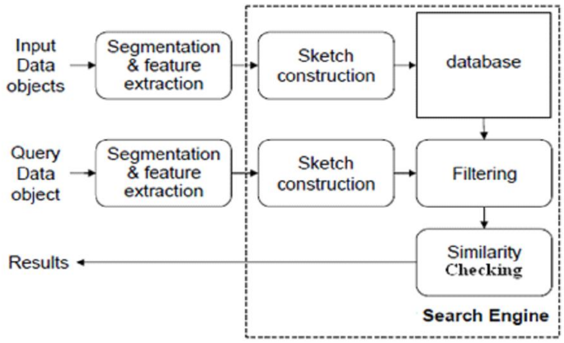

Figure 2: Searching Process (Steps)

After receiving the input object segmentation and feature extraction of multimodal data, input data object is passed to a data specific segmentation and feature extraction unit, which is provided by the programmer. This unit will segment the input data object and generate a feature vector for each segment. Each data object is now represented by a set of feature vectors which are then passed to the sketch construction unit. The sketch construction component converts each feature vector into a compact bit vector. The sketches will then be passed to the database which is managed by the metadata management component. When a query is presented to the similarity search engine, the query data is first passed to the same segmentation and feature extraction unit. Similar to processing the input data, the unit will segment the query data into segments and generate a set of feature vectors. The feature vectors will be passed to the sketch construction component to convert them into a set of sketches for the filtering unit and similarity checking unit and shows the result.

VI.RESULT & CONCLUSIONS

To obtain the search result from the content base environment, we measure the three parameters:

a. Search speed: we use the average running time of all the queries on our benchmark datasets.

b. Space requirement: we use different sketch sizes and show the corresponding search quality and search speed.

c. Similarity search quality: we use three commonly used search-quality metrics: first-tier, second-tier and average precision:

i. **1st tier** is the percentage of data objects in the query similarity set that appear within the top k search results, where k depends on the size of the query similarity set Specifically, for a query similarity set Q, k = |Q|”1. The first-tier statistic indicates the recall for the smallest k that could include 100% of the data objects in the query similarity set.

ii. **2nd tier** is similar to the first tier except that k =2 x (|Q| “ 1). The second-tier is less stringent since k is twice as large. The ideal result is still 100% and higher values mean better similarity search results.

iii. **Average precision** considers where data objects of a query similarity set appear in the search results. Consider a query q with an unordered gold standard set Q and k = |Q| “ 1. Let $rank_i$ be the rank of the *i*-th data object of Q in the ordering returned by the search operation. For evaluation purposes, we will assume that any data item not returned in the result set by the search procedure has a default rank equal to the size of the dataset. Then average precision is defined as follows:

$$\text{Average precision} = \frac{1}{k}\sum_{i=1}^{k}\frac{i}{rank_i}$$

All results reported in this paper are average numbers obtained by running experiments multiple times

TABLE I:
RESULT FROM SEARCH QUALITY

Input Type	1st Tier	2nd Tier	Avg Precision	Feature Vector Size(bits)	Sketch Size (bits)	Size ratio
Image	0.52 0.40	0.61 0.45	0.59 0.39	446 261	93 N/A	4.8:1 N/A
Audio	0.68 0.70	0.74 0.76	0.72 0.73	6,154 6,625	600 N/A	10.3:1 N/A
3D Shape	0.33 0.35	0.40 0.43	0.31 0.33	17,472 17,472	800 N/A	21.8:1 N/A

For search quality and speed we do experiment with the search-quality benchmark suite. For each benchmark dataset, we used the first data object in each “gold standard” similarity set as the query data object to obtain result. We also compared our results with the best known domain specific search tools. Table 1 reports our results. The results show that all three systems achieve good search quality for the benchmarks. For the image benchmark, our image search system achieves much better search quality (average precision of 0.59). For the audio benchmark, our system achieves average precision 0.73. For the 3D shape models, our system achieves almost the same search quality numbers 0.33. Table 2 shows the results from the search-speed benchmark.

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TABLE II:
RESULTS FROM THE SEARCH-SPEED BENCHMARK SUITE

Benchmark	No. of Data Objects /Object Time	Average Segment / Objects	Avg. Search Times (s)
Image	660,00	10.8	2.0
Audio	6,300	8.6	0.09
3D Shape	40,000	1	0.01

In this paper, we present the efficient searching algorithm from the content based environment. Using this, we have built E-Learning multimodal direct search systems for image, audio, and 3D shape model data. An external research group has also used for genomic data analysis. Our experience has shown that it is straightforward to use Content Based Retrieval method.

In summary, there is a great need to extract semantic indices for making the CBR system serviceable to the user. Though extracting all such indices might not be possible, there is a great scope for furnishing the semantic indices with a certain well-established structure. Fortunately, our work shares many goals with several other active Web-related research areas, enabling us to re-use possible standards, solutions and ideas from these areas. It gives our group, along with other similarly-motivated groups, a good chance of succeeding in bringing this new generation of adaptive E-Learning systems and tools to the educational world. We need more time to find out more optimum searching methodology to search content. We are now working on a content-based portal and coordinating for content organization, designing and developing content. And also we are supporting learner's requirements over the portal. Our future research work will be to design a more effective and efficient methodology for content based E-Learning systems.

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